

Price Elasticity of Demand (PED)

- PED and its determinants
- The total revenue test of PED
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Cross Price Elasticity of Demand (XED)

- XED and its determinants
- Applications of XED

Income Elasticity of Demand (YED)

- YED and its determinants
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Price Elasticity of Supply (PES)

- PES and its determinants
- Applications of PES

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Introduction to Elasticities

Elasticity is an economic concept which refers to the responsiveness among consumers or producers to a change in a variable which affects either the market demand or the market supply. There are four types of elasticity that we will study in this unit:

- **Price Elasticity of Demand (PED):** *Measures the responsiveness of consumers of a particular good to a change in the good's price.*
- **Cross-price elasticity of Demand (XED):** *Measures the responsiveness of consumers of one good to a change in the price of a related good (either a substitute or a complement).*
- **Income Elasticity of Demand (YED):** *Measures the responsiveness of consumers of a particular good to a change in their income.*
- **Price elasticity of Supply (PES):** *Measures the responsiveness of producers of a particular good to a change in the price of that good.*

1.2 Elasticities

PED



Price Elasticity of Demand – definition and formula

Price Elasticity of Demand (PED) is a measurement of *how much the quantity demanded for a good will change as a result of a particular change in the good's price*. PED can range from a value of 0 to infinity, and is calculated using the following formula:

PED = The percentage change in the quantity of a good demanded / The percentage change in the price of the good
or... $\% \Delta Q_d / \% \Delta P$

If, for example, we know that an increase in the price of bananas from \$4 to \$6 caused the quantity demanded to fall from 1,000 bananas to 800 bananas, we can calculate the PED for bananas.

$$\% \Delta Q_d = 800 - 1000 / 1000 = -0.2 \times 100 = -20\%$$

$$\% \Delta P = 6 - 4 / 4 = 0.5 \times 100 = 50\%$$

$$\textbf{PED} = \textbf{-20/50} = \textbf{-0.4}$$

Notice that since we did not KNOW the percentage changes in P and Q, we had to calculate them. The full PED formula is

$$\textbf{PED} = \textbf{Q2 - Q1 / Q1} \div \textbf{P2 - P1 / P1}$$

Price Elasticity of Demand – definition and formula

Notice from the previous slide that our PED was a negative value.

- This reflects the *law of demand*
- Whichever direction the price of good moves in, the quantity will always move in the other direction
- Since PED will *always be negative*, we can refer to it in its absolute value. So, the PED for bananas is 0.4

Interpretation of the PED coefficient:

If PED is less than 1:	We say demand is <i>inelastic</i> . This means that the percentage change in the quantity is less than the percentage change in the price.
If PED is greater than 1	We say that demand is <i>elastic</i> . The percentage change in the quantity is greater than the percentage change in the price.
If PED=0:	Demand is <i>perfectly inelastic</i> . There was no change in quantity resulting from the price change.
If PED=1:	Demand is <i>unit elastic</i> . The percentage change in the quantity was identical to the percentage change in the price.
If PED = infinity:	Demand is <i>perfectly elastic</i> . The smallest increase in price causes the quantity demanded to fall to ZERO.

I.2 Elasticities

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INTRODUCTION TO PRICE ELASTICITY OF DEMAND – CALCULATING PED
USING DATA FROM A DEMAND DIAGRAM

1.2 Elasticities

PED



Interpretation of PED

Demand for bananas was 0.4. Based on our interpretations of PED from the table on the previous slide, we know that demand for bananas is *inelastic*.

- For every 1% increase in the price of bananas between \$4 and \$6, the quantity demanded fell by 0.4%.
- Since price increased by a total of 50%, the quantity fell by a total of just 20%.
- Consumers are *relatively unresponsive to the price of bananas*.

Study the tables on the right and try to determine what the goods in each category have in common.

Inelastic		Approximately Unitary Elasticity	
Salt	0.1	Movies	0.9
Matches	0.1	Housing, owner occupied, long-run	1.2
Toothpicks	0.1	Shellfish, consumed at home	0.9
Gasoline, short-run	0.2	Oysters, consumed at home	1.1
Gasoline, long-run	0.7	Private education	1.1
Residential natural gas, short-run	0.1	Tires, short-run	0.9
Residential natural gas, long-run	0.5	Tires, long-run	1.2
Coffee	0.25	Radio and television receivers	1.2
Fish (cod) consumed at home	0.5	Highly Elastic	
Tobacco products, short-run	0.45	Restaurant meals	2.3
Legal services, short-run	0.4	Foreign travel, long-run	4.0
Physician services	0.6	Fresh green peas	2.8
Taxi, short-run	0.6	Chevrolet automobiles	4.0
Automobiles, long-run	0.2	Fresh tomatoes	4.6

Interpretation of PED

Answer the following questions based on the goods in the table on the previous slide.

1. Which products are the most inelastic?
2. What factors would most likely explain why salt is very inelastic?
3. Why would the demand for tooth picks be inelastic?
4. Although both short-run and long-run gasoline are both inelastic, why is short-run gasoline more inelastic than long-run gasoline?
5. What factors would likely explain why Chevrolet cars are very elastic?
6. Why would tires have unitary elasticity while gasoline is inelastic?

1. [Inelastic goods = salt, matches, toothpicks, short-run airline travel, gasoline, residential natural gas, coffee, fish, tobacco, legal services, physician services, taxi service, automobiles]

2. [Salt is inelastic because there are no good substitutes, it is a necessity to most people, and it represents a small proportion of most people's budget.]

3. [Toothpicks are inelastic because they cost very little and represent a small percentage of a typical grocery budget and have few substitutes.]

4. [Short-run gasoline is more inelastic than long-run because in the short run, we have to buy gas to keep our car going. In the long run, we can switch to more fuel-efficient cars (including hybrid), ride the bus or walk more. But the short-run, those options are not available.]

5. [Chevrolet cars would be very elastic because we don't have to buy that brand of car - we have lots of substitutes.]

6. [Even though tires are a want if we drive a car, the decision to buy them is not as immediate as buying gas (unless we have a flat and must buy one to get back on the road). You can shop around for the best price as there are a number of brands and stores that sell tires. You can buy new or used tires so you have some substitutes. So even though we think of tires as wants, there is a greater flexibility in buying tires than in buying gasoline. This contributes to the higher elasticity of tires over gasoline.]

The Determinants of PED

Whether demand for a good at a particular price is elastic or inelastic depends on several characteristics of the good itself. Just how much will consumers respond to a price change for the good? **The following table presents some of the primary *determinants of PED***

S	Substitutes	The number of substitutes available. The more substitutes, more elastic demand, as consumers can replace a good whose price has gone up with one of its now relatively cheaper substitutes.
P	Proportion of income	The proportion of income the purchase of a good represents. If a good represent a higher proportion of a consumer's income, his demand tends to be more elastic.
L	Luxury or necessity?	Luxury or necessity? If a good is a necessity, changes in price tend not to affect quantity demand, i.e. demand is inelastic. If it's a luxury that a consumer can go without, consumers tend to be more responsive.
A	Addictive?	If a product is addictive or habit forming, demand tends to be inelastic.
T	Time	The amount of time a consumer has to respond to the price change. If prices remain high over a longer period of time, consumers can find substitutes or learn to live without, so demand is more elastic over time.

1.2 Elasticities

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The Determinants of PED

Based on the determinants of PED, organize the items below along the spectrum of elasticity, from those which you believe have relatively inelastic demand to highly elastic demand.

Relatively inelastic.....Relatively Elastic



Applications of PED

The PED formula is useful for more than just telling us how much consumers respond to price changes. It can be very useful to businesses and government decision making.

Applications of PED for

Businesses

Businesses benefit from knowing how responsive their consumers are to price changes at any given time.

- If a seller knows demand is HIGHLY elastic, he may wish to lower the price and capture many new customers.
- If a seller knows demand is highly inelastic, he may wish to raise his price as he will not lose many sellers but will enjoy higher revenues.

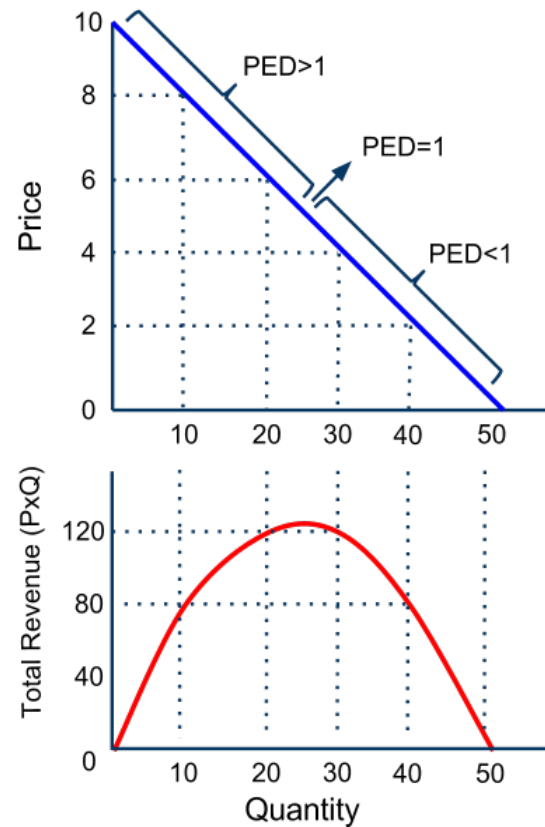
Government

The government needs to know how consumers will respond to taxes imposed on particular goods. For example, if the government wishes to raise revenues from taxing goods, it should know that:

- A tax on restaurant meals (relatively elastic) will not raise much revenue because people will just stop going to restaurants.
- A tax on cigarettes (relatively inelastic) will raise lots of revenue because most people will continue smoking and thus have to pay the tax.

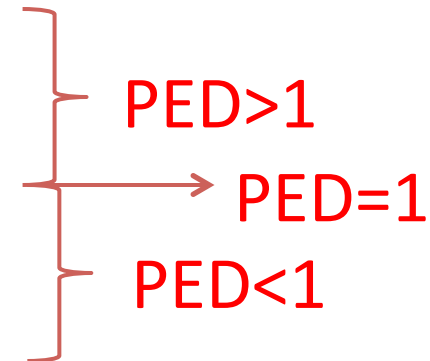
The Total Revenue Test of PED

A quick way to determine whether a demand is elastic or inelastic is to consider whether the revenues of sellers raises or falls as a result of a price change.



Consider the good whose demand is shown on the left: Calculate the total revenues at each of the prices shown. (Total Revenue=Price x Quantity)

- At \$10: $TR = 10 \times 0 = 0$
- At \$8: $TR = 8 \times 10 = 80$
- At \$6: $TR = 6 \times 20 = 120$
- At \$4: $TR = 4 \times 30 = 120$
- At \$2: $TR = 2 \times 40 = 80$
- At \$0: $TR = 0 \times 50 = 0$



The Total Revenue Test of Elasticity:

- *If a decrease in price causes TR to rise, demand is elastic.*
- *If a decrease in price causes TR to fall, demand is inelastic*
- *If an increase in price causes TR to rise, demand is inelastic*
- *If an increase in price causes TR to fall, demand is elastic*

I.2 Elasticities

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PRICE ELASTICITY OF DEMAND AND THE TOTAL
REVENUE TEST

1.2 Elasticities

PED



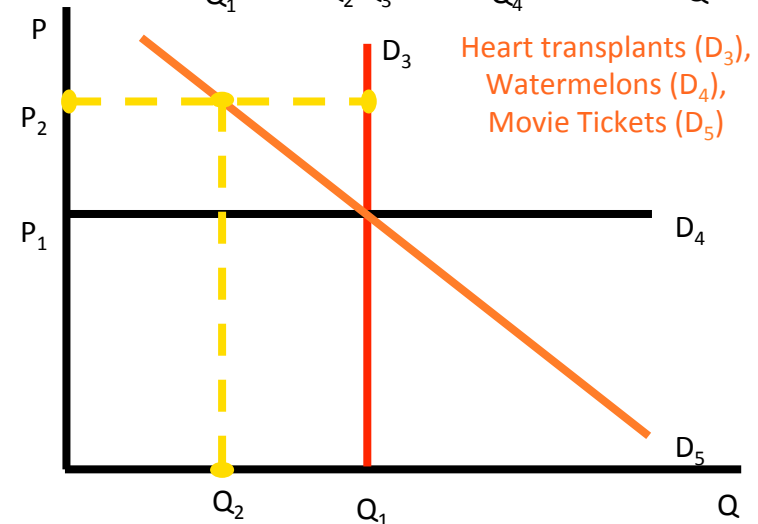
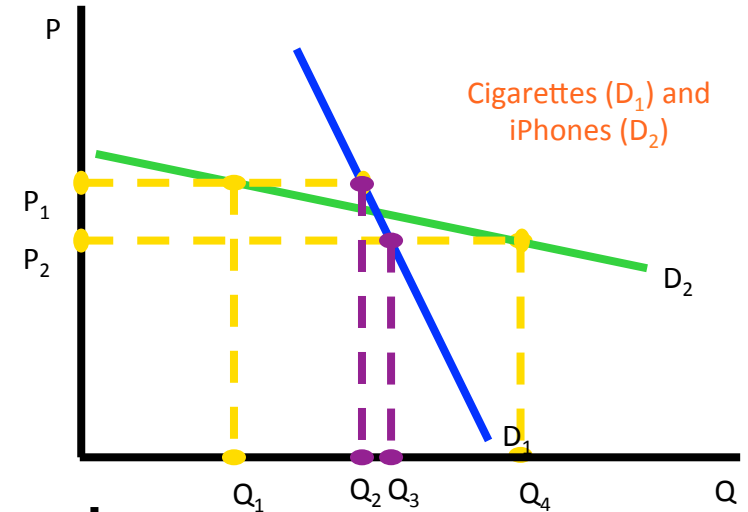
PED and the slope of the Demand Curve

PED and slope are different concepts.

- Slope of a line measures the rise over the run, or in the demand curve the change in price over the change in quantity.
- PED measures the *percentage change in quantity over the percentage change in price*.
- **However**, by comparing the relative slopes of demand curves plotted on the same axis, we can determine the relative elasticity of different goods.

Questions:

1. For which product is demand perfectly inelastic? Perfectly elastic? Closes to unit elastic?
2. What relationship exists between relative slopes of demand curves and elasticity?
3. What are two characteristics of cigarettes that make demand for them inelastic?
4. What are two characteristics of heart transplants that make demand perfectly inelastic?
5. What are the characteristics of a good for which demand is perfectly elastic?



PED Discussion Questions

Discuss the following question about PED with your class.

1. Why do buyers of some products respond to price increases by reducing their purchases more than the buyers of other products?
2. Why do higher market prices for some products cause producers to greatly increase their output while price rises for other products cause only limited increase in output?
3. Why does the demand for some products rise a great deal when household income increases while the demand for other products rises just a little?
4. Is PED for a particular good the same at all prices? Yes or no. If no, then why would PED change as the price changes?
5. Illustrate the concept of changing PED along a straight line demand curve.
6. How does the PED for a good affect the producer's decisions on how to set prices?

Cross Price Elasticity of Demand (XED)

Another type of elasticity measures the responsiveness of consumers of one good to a change in the price of a related good.

For Example: Consider apples and pears, two fruits that are close substitutes for one another.

- *How will demand for pears be affected by an increase in the price of apples?*
- *XED tells us the percentage by which quantity of pears will change following a particular percentage change in the price of apples.*

$XED = \text{Percentage change in the quantity of Good A} / \text{Percentage change in the price of Good B}$ or $\% \Delta Q_A / \% \Delta P_B$

Assume the following:

- Apples go from \$2 to \$2.50
 - $P_1 = \$2$, $P_2 = \$2.50$
- The quantity of pears rises from 30 to 50
 - $Q_1 = 30$, $Q_2 = 50$

$$XED_{\downarrow AP} = (50 - 30) / 30 \div (2.5 - 2) / 2 = 0.67 / 0.25 = 2.7$$

*Demand for pears is cross price elastic
with apples (i.e. $XED > 1$)*

Cross Price Elasticity of Demand (XED)

Just like PED, the absolute value of XED can be:

- **0-1: Inelastic** – Consumers of Good A are relatively unresponsive to a change in the price of Good B (the % change in Q_A will be smaller than the % change in P_B)
- **1: Unit Elastic** – Consumers of Good A will respond proportionally to a change in the price of Good B (the % change in Q_A will be the same as the % change in P_B)
- **>1: Elastic** – Consumers of Good A will be relatively responsive to a change in the price of Good B (the % change in Q_A will be greater than the % change in P_B)

Complementary goods: The XED for complementary goods will always be *NEGATIVE*, because when the price of one complement goes up, the demand for the other will FALL.

- **Example:** Price of hot dogs rises, the demand for hot dog buns will decrease. XED coefficient will be negative, reflecting the inverse relationship

Substitute goods: The XED for substitutes will always be *POSITIVE*, because when the price of one substitute goes up, the demand for the other will RISE.

- **Example:** The price of beef rises, the demand for pork will rise. XED coefficient will be positive, reflecting the direct relationship

[Blog post: A cross-price elasticity example – gasoline and obesity](#)

Income Elasticity of Demand (YED)

Another type of elasticity measures the responsiveness of consumers of a good to a change in the income.

For Example: Imagine a country is going into recession, so incomes of the average household are falling. Demand for new cars is falling, but demand for bicycles is rising. YED is a measure of how responsive consumers' demand for bicycles and cars is to changes in their incomes.

$YED = \text{Percentage change in the quantity of a good} / \text{Percentage change in consumers' income}$ or $\% \Delta Q / \% \Delta Y$

Assume the following:

- Incomes in America have fallen by 4%
- Bike sales have risen by 8%
- Car sales have fallen by 3%
- Calculate the YED for bicycles and cars

$$YED_{\downarrow \text{bikes}} = 8 / -4 = -2$$

$$YED_{\downarrow \text{cars}} = -3 / -4 = 0.75$$

**Notice that YED can
be negative (bikes) OR
positive (cars)**

Demand for bikes is income elastic

Demand for cars is income inelastic

Income Elasticity of Demand (YED)

As with PED and XED, the absolute value of YED can be:

- **0-1: Inelastic** – Demand for the good is relatively unresponsive to changes in consumer income (quantity will change by a smaller percentage than the change in income)
- **1: Unit Elastic** – Demand for the good is proportionally responsive to income changes (quantity will change by the same percentage as the change in income)
- **>1: Elastic** – Demand for the good is relatively responsive to changes in income (quantity will change by a larger percentage than consumers' income)

Normal goods: A normal good is one with a POSITIVE YED coefficient. There is a direct relationship between income and demand.

Example: As incomes fell, car sales fell as well. If incomes were to rise, car sales would begin to rise. Cars are a normal good.

Inferior goods: An inferior good is one with a NEGATIVE YED coefficient. This is a good that people will buy more of as income falls, and less of as income rises.

Example: Bicycle transportation is an inferior good, because Americans demanded MORE bicycles as their incomes fell. If income were to rise, bicycle sales would begin to fall.

[Blog post: Is bicycle transportation an “inferior good”?](#)

Price Elasticity of Supply (PES)

This is a measure of the responsiveness of producers to price changes. Since there is always a direct relationship between price and quantity supplied, the PES coefficient will always be positive. PES can be calculated using the same formula as the other types of elasticity:

PES = Percentage change in the quantity supplied / Percentage change in the price or..
 $\% \Delta Q \downarrow S / \% \Delta P$

PES will always be positive, since there is a direct relationship between the price of a good and the quantity firms wish to supply.

Consider the following:

- The price of tablet computers rises from \$400 to \$500
- In the week that follows, the quantity rises from 1 million to 1.1 million
- In the three months that follow, the quantity rise from 1 million to 2 million

PES in the short-run (1 week after price change)

$$PES \downarrow SR = 1.1 - 1 / 1 \div 500 - 400 / 400 \\ = 0.1 / 0.25 = 0.4$$

PES in the long-run (3 months after price change)

$$PES \downarrow LR = 2 - 1 / 1 \div 500 - 400 / 400 \\ = 1 / 0.25 = 4$$



The Determinants of PES

The primary determinant of PES is the amount of time producers have to respond to a price change.

- In the tablet computer market (previous slide), producers were relatively unresponsive to the rise in price in the one week following the price increase (PES equaled only 0.4)
- After three months, producers had the time to increase their production to meet the higher demand, thus they were much more responsive (PES equaled 4)

Three time periods help determine PES:

MARKET PERIOD

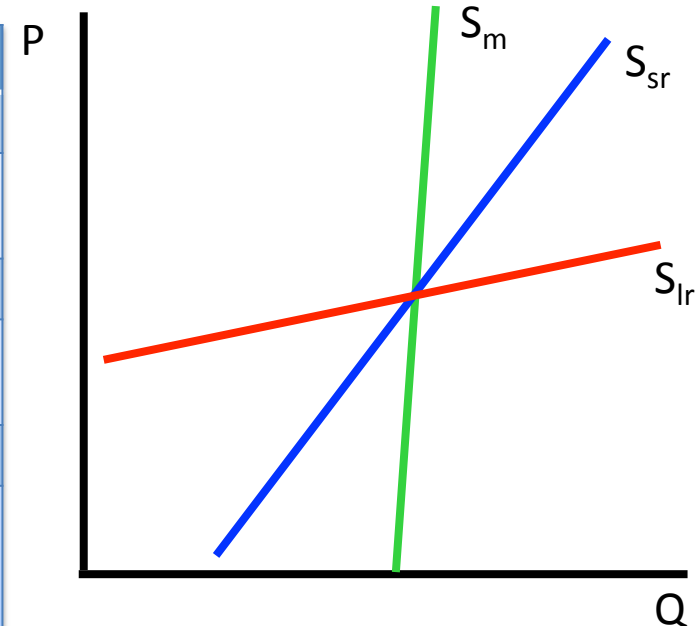
Immediately after a change in price. Supply is highly inelastic, because firms cannot immediately produce more of a good. S_m in the graph.

SHORT-RUN

Firms can use their fixed capital more or less intensively, so supply is more slightly more elastic.. S_{sr} in the graph.

LONG-RUN

Firms have time to vary the amount of capital they use, so supply is highly elastic. In the long-run an increase in price will result in a much greater increase in Q_s than in the market period or the short-run. S_{lr} in the graph.



The Determinants of PES and Applications of PES

In addition to the amount of time following a price change, the following help determine PES:

- **The mobility of resources:** If resources (labor and capital) can be quickly put into or taken out of the production, supply tends to be more elastic. Generally, this applies to low-skilled manufactured goods, the supply of which is more elastic than high-tech, capital-intensive manufactured goods.
- **The ability to store stocks:** If large inventories can be kept, producers can respond to price rises by drawing on those inventories to meet rising demand and to price declines by adding to inventories in response to falling demand. Goods which can be stored tend to have more elastic supply than perishable, non-storable goods.

Applications of PES: Similar to PED, a knowledge of PES can help businesses and the government better plan for the anticipated price changes to particular goods.

- **Business firms:** If a producer expects the price of his product to change in the future, he will want to adjust his output accordingly. Being able to adjust output in a timely manner to price changes is key to maximizing a firm's profits.
- **Government:** A government must consider the PES for a good if it is considering intervening in the market for that good in any way. For example, if a government is considering imposing price controls (maximum or minimum prices) on an agricultural commodity, the PES should be considered so any changes in output resulting from the government controlled price can be anticipated.

[Blog post: The problem with price controls in Europe's agricultural markets](#)

[Blog post: Calculating the price elasticity of supply of natural gas](#)